Safety When Working with Acids

- When mixing solutions, the acid is always added to the water, never the reverse. Water added to acid will boil violently and splatter. A phrase to help you remember this rule is: *Acid to watter, like to outta* (said with a Brooklyn accent).
- All acids used in jewelry and metalsmithing (nitric, sulfuric, hydrochloric, etc.) are potentially hazardous to your health. They are highly caustic to the skin and eyes, vapors can damage the respiratory system and heating generates irritating and sensitizing sulfur dioxide gas. Heated metal should never be quenched in pickle. *A safety rule in the studio is that you must always wear goggles when working with any acid solutions.*
- The pickle solutions in the studio are to be changed only by the GA, an instructor, a BFA or Grad student in the department. The solutions are too be kept at a lower temperature, never let the pickle boil and always keep the lid on.
- If you get pickle in your eye, immediately go to an eyewash station and flush your eyes with water for at least 15 minutes, then seek medical attention. An eyewash station is next to the sink in the beginning room and there is another in the chemical room.
- If you spill an acid, neutralize it with baking soda. Wash your hands thoroughly after deailing with acids or wear neoprene gloves when necessary.

Preventing Pickle Contamination

No iron or carbon steel is allowed in any of the pickle solutions (i.e. no tweezers, steel wool, binding wire, etc.). If steel is introduced into the pickle, it will contaminate the solution and any metal placed in that bath will copper plate. There is a separate pickle for sliver and another for copper and brass. Use copper or stainless steel tongs for removing pieces from the pickle.

Torch Information

We will be using natural gas/air torches and Acetylene B tanks.
Please pay careful attention to all demonstrations for proper use and safety precautions.

- A large flame should be used to heat a large piece of metal.
- The size of the flame can be varied by increasing the amount of gas.
- The intensity of heat of the flame will then be varied by the increasing or decreasing the amount of oxygen or air that you mix with the gas.
- Light a gas/air torch by first igniting the gas with a striker (No Lighters) and then turning the air valve.
- Turn off the torch by first turning off the air and then the gas (make sure that you have turned the amount of gas down so when you turn off the air, you won't have a big gas fireball).
- In order to avoid possible burn, be careful to turn on only a small amount of gas when lighting the torch.
- Make sure there are no flammable objects (loose hair, clothing, paper towels, etc.) near the torch area

Beginning Metalsmithing and Jewelry Design

ACETYLENE TORCH OPERATION AND SAFETY

TO TURN ON:

In the event that a tank is turned 'off', the first person to use the torch should follow these instructions:

1. Select the correct tip based on the size of flame needed (#1A is the smallest, #4 is the largest). Unscrew the previous tip counter-clockwise direction and screw in the new tip in a clockwise direction – tighten and lock tip in desired position using the locking mechanism at the base of the torch tip. Make certain you have positioned the tip pointing away from you with fuel knob on the left side if you are right-handed and on the right side if you are left-handed.

2. Next, loosen the air/fuel pressures adjustment knob on the regulator. Screw out until at least 1/8" of the thread is exposed. PLEASE NOTE: If you do not relieve the pressure gauge on the regulator you can cause it to explode causing injury to yourself or possible ruining the regulator. Do not open the tank valve until you complete this step.

3. Now you are ready to open the acetylene tank valve. Open the tank by slowly turning the tank valve key to the left (counter-clockwise) direction no more than one quarter turn. The regulator dial should then register the amount of fuel remaining in the tank. Remember: Lefty Loosey, Righty Tighty

4. Now you can light the torch using a striker placed directly under the tip.
   NEVER USE A LIGHTER OR MATCHES TO LIGHT THE TORCH. After lighting the torch, the flame may be too low in heat or too high in heat, depending on the regulator setting and the amount of fuel left in the tank. To adjust the air/fuel pressure which controls the heat of your flame, screw in the regulator knob one turn in a clockwise direction. After you have adjusted the flame of your torch to the proper heat you are ready to begin soldering.

TO TURN OFF:

When you are finished soldering, turn the gas flow off at the torch handle by slowly turning the fuel knob (on the handle of the torch) clockwise. This is done slowly to prevent a flashback which is indicated by a loud 'popping' sound in the handle. To shut down the tank, follow these instructions:

1. Shut off the fuel supply to the regulator by turning the tank valve key to the right (clockwise) direction until it is tight, but do not overturn or use excessive force.

2. Next, the gas needs to be released from the hose that supplies the fuel from the regulator to the torch handle. This is called "bleeding a line." Open the handle fuel knob and let the excess gas escape. The safest method is to light the torch and burn the unwanted gas until the flame expires. Also, the regulator dial should register EMPTY. If the regulator hand should move, you have not closed the valve tight enough or there is gas in the line.

** IMPORTANT: If you ever have a problem with any of the torches, tell your Instructor or the GA immediately. Any noticeable smell of Natural Gas or Acetylene Gas should be researched and reported if the source of the leak is not found and cannot be remedied. Call the Art Secretary, Building Operations, Physical Plant, or Campus Security after 4pm. **

Heating Metal

During the forming process, the metal becomes hard from the compression of its molecular structure by hammering, bending, twisting, or drawing the metal. This condition is called *Work Hardened* and if this continues, the metal will crack at the edges or on the surface. To restore the metal's malleability, the process of *Annealing* is necessary. Re-heating the molecules in the metal again will make the surface more pliable and the stresses in the metal are released.

The danger that exists from annealing is overheating. Heating the metal above annealing temperature will often destroy the metal's working qualities. If the metal is accidentally overheated, do not quench the piece as is normally done, (this can warp or even crack the metal.) Rather, let the piece air cool and begin the process again.

You must anneal a piece of metal again once it has become hard and stiff and does not move easily with a hammer. If you are going to be bending flat sheet metal, it is best to anneal it before working on it.

Oxidation

Oxidation is the black discoloration that forms on the surface of metal when it is heated to soldering or annealing temperatures. This metal oxide residue is cleaned off or removed by placing the piece in acid or pickle.

Cleaning

After annealing and quenching a piece, cleaning may be accomplished in a diluted acid solution of 10 parts water to 1 part acid. Sulfuric acid is used for copper, brass and silver. For general cleaning of non-ferrous metals in this studio, we will use a less hazardous, dry granule acid with the trademark name of *Sparex* (Sodium Bisulfate). *Sparex* is mixed with water in a weak solution and is then heated to speed up cleaning process. Nitric Acid may be used but it is not recommended except in certain cases stripping off oxidation. Metal should be dipped in an a solution of baking soda to neutralize the acid and then rinsed in water.

Remember: All acids are potentially hazardous to your health. For this reason, do not change acid solutions unless you have been properly instructed how to do so. The acids are to be kept at a low temperature. *Never let the acid pots boil!* Wear goggles and never wear contacts around acids. The eyewash location is marked. If you spill acid, clean with baking soda paste to help neutralize the acid. Wash your hands thoroughly after dealing with acids and wear rubber gloves when necessary.

No Iron or steel in any of the acid containers (i.e. no tweezers, steel wool, binding wire, etc.). If steel is introduced into the acid solution, a chemical reaction creates copper sulfate and any metal placed in the bath will copper plate. There is a separate bath for silver to help prevent contamination. There is also a separate *Nickel Pickle* for cleaning pieces made with Nickel.

Firescale

Firescale forms on the surface of the metal when it is heated in air. On silver, it looks like a dark gray purple cloud on the surface of the metal (it forms on sterling due to the copper oxides that are formed by the sterling's copper content). There are special processes needed to remove this firescale when finishing silver.

Depletion Plating (Raising the Fine Silver)

There is an extra cleaning process that needs to be done in the case of Sterling Silver. If you have filed or sanded the silver, you will see the fire scale on the surface after cleaning the piece in acid. These purple or gray spots have come to the surface because the Fine Silver "skin" that was originally on the surface of the milled sheet metal has been removed. When the piece is completely finished (except for the addition of stones, plastics, or pin stems), the fine silver needs to be "brought up" or "raised" to cover the firescale. To do this, first warm the piece with a torch (soft, bushy flame) just beyond the touchable heat. When the piece is air cooled, cleaned in acid (pickle), rinsed, and polished with a brass brush and soap under running water. This process is repeated three or more times until the final heating produces an even white color all over the surface of the silver. The piece is then polished using a fine brass brush with water and a drop of degreasing dish soap.

Soldering

Soldering is the process of fusing two pieces of metal together using another metal with a lower melting point. The Egyptians discovered that different natural ores that they found would melt at different temperatures and they could use these lower ores to fuse the pure ones together. This discovery made it possible to solder pieces of metal together.

Fine or Pure silver melts at a temperature of 1761 degrees Fahrenheit. When a small amount of brass is mixed with molten silver, it will lower the temperature needed to re-melt it. Adding more alloys (copper and *zinc)* to the silver will cause the melting point to lower even further. These different mixtures of silver and are called solder.

There are five grades of silver solder on the market. We will be using three of these grades. Hard Solder has a melting temperature of over 1450 degrees Fahrenheit. Soft or Easy solder requires a melting temperature of 1325 degrees Fahrenheit. There is also an in between level of solder called Medium Solder. These solders may be purchased in sheet or wire form. We will use wire solder.

NOTE: Do not buy Solder at a hardware store or any other type of solder that is not specifically made for jewelry as these solders may contain lead.

In order to solder one metal to another, the surfaces of the metal must be clean and must be kept clean during the soldering process. When metal is heated it becomes covered in oxides, preventing the flow of solder. Flux is the solution that is used to cover the seam that is being heated and soldered. We are using the brand *Dandix* flux in this class because it does not contain fluorides. As the flux is heated, it becomes fluid and glass-like. At this point, the solder should flow. If prolonged heating occurs, the flux will break down and will lose its cleansing abilities. After soldering a seam, the flux will no longer work. To continue soldering, the piece must be cleaned in acid or *Sparex* to clean the seam and then new flux and new solder must be used.

Steps for Soldering: ***Preparation is key!***

1) Fitting
The joints that you want to solder together must fit tightly. Solder is not a filler and will not fill gaps (like a welding process). Therefore, you must file the edges of the seam so that not light will show through when the pieces are put together.

2) Cleaning
Remove all grease, oil and oxides from the surface of the metal that is to be soldered. You can do this by sanding the joints lightly with 600 sandpaper, or pumice and a green scratch pad. Be sure not to touch the seam after you have degreased it.

3) Fluxing
Apply flux to both the joint and the piece of solder. Apply the wet flux with a brush to the metal surfaces and dip the piece of solder in flux from the brush. You can put the pieces of solder on the seam at this point or wait until you have heated the metal a bit.

4) Cutting Solder pieces
Cut the solder wire into about 1/32" pieces with your wire snips, depending on the size of the piece. Place the solder on the seam so that it is touching both surfaces that are being soldered. Try to get the solder seam to be in a place on the piece that will be easier to clean after it has flowed.

5) Heating
Heat the area around the piece first and then slowly heat the piece to get the flux to dry white. If you heat the seam right away, the solder may jump off. *Remember, you are not heating the solder, you are trying to get the metal to heat to the right temperature and make the solder flow on its own.* Heat both pieces of metal so they reach soldering temperature at the same time.

If one surface is hotter than the other, solder will flow to the hotter surface first. If the pieces that you are solder together are unequal in size, heat the larger surface more to make up for the smaller piece's ability to heat up faster.

When you have finished soldering, let the piece air cool until is cool to the touch, (to avoid warping). You may then place the piece in Acid to clean the oxides or firescale that has developed. Rinse the piece in Baking Soda solution first to neutralize the acid and then rinse the piece with water. It is important to rinse all of the acid off of your piece. Do not leave the piece in the acid too long (longer than it takes to clean the piece) or the acid will begin to eat at the zinc in the solder and therefore eat away at the solder seams that you've worked so hard to make.

Types of soldering joints:

There are four different types of soldering joints that we will be investigating. They are:

1) Butt Joint ~ Two pieces of metal set edge to edge.

2) Right Angle - ~ One edge and the side of another piece of metal set together at right angles.

3) Sweat Solder ~ One pieces of sheet metal soldered on top of another piece of metal.

4) Married Metal ~ Different types of metal soldered next to each other and then finished to one sheet or flat surface.

Notes:

To re-flow solder seams or to separate two seams that have already been soldered, re-flux and re-heat the seam that you want to be separated.

Except in rare cases, the torch flame should be moved constantly during the soldering process to reduce the risk of melting the metal.

Solder flows when both pieces of the METAL are at the correct melting temperature. The entire piece needs to be hot. Therefore, heat the entire piece evenly and when the flux turns clear, concentrate the flame on the seam to be soldered.

Watch the pieces of solder or, if they are not visible, the seam where the solder will flow. As soon as a bright silvery line of molten solder is visible and the solder flows along the joint, remove the heat.

Solder will always flow in toward the direction of the most heat. It can also be pulled though a seam with the heat of the torch.

Sometimes, seams are held together by flux rather than solder. The strength of the seam will become clear when the piece is cleaned in acid.

Reasons for Solder Failure:

1. Incomplete solder flowing, gaps and pitting.

Fix: After cleaning in acid, reflux and reheat piece with new solder (if any has fallen off).

2. Solder balling and refusing to flow.

Cause: Metal/Solder surfaces may be dirty with grease, oil, or oxides. Excessive preheating may cause oxides or cause flux to be supercharged with oxides, thus no longer absorbing or preventing oxidation. Too much heat concentrated on one part of a piece may cause the piece to cool elsewhere. An incorrect flame (too much or too little air) may cause soot or oxides. Heating too slowly, even if the correct temperature is reached, may cause the flux to burn off. Prolonged high heat may cause too much oxidation and metal warpage. Incomplete solder contact; since solder cannot fill gaps, the seam must fit as perfectly as possible.

3. Foreign matter

Through carelessness, particles or charcoal, firebrick, or even metal filings might remain in the seam to be soldered which will prevent them from fusing together. Always have a clean seam and use only what you know to be solder.

4. Accidental use of wrong solder

Always keep solders of different melting points in separate labeled containers. Delicate work can be ruined before the mistake is realized. In general, it is best to construct a piece using as much hard solder as you can. The reason is because hard solder contains the most silver in its alloy and the seam is less noticeable in the completed piece.

5. Careless use of Liquid Paper or Yellow Ocher

Both of these substances (used to prevent solder from flowing) when mixed accidentally with flux, can completely prevent solder flow. Keep fluxed areas from those painted with these materials

6. Poor fitting parts

This causes most difficulties since solder cannot bridge gaps between surfaces or flow along wire when it is not completely in contact with its support. Though it is sometimes possible to press a warped sheet or wire into place while applying heat, great damage may result if work becomes too hot while doing so. Most metals become brittle at high temperatures and can be shattered by forcing them to move. You will avoid many headaches if the correct fitting is established from the beginning.

7. Moving parts before or after solder flow

Sometimes, if a piece has moved during the heating process and before the solder has begun to flow, they may be pushed back into position. Make sure that the solder is also reposition to avoid lengthy cleanup. You can move pieces when the solder is still fluid with your poker. Do Not remove the heat since this will make the solder solidify immediately, making reflowing difficult. *If a removed piece refuses to be repositioned, do not heat for longer than one try at correction.* Prolonged heating will cause the zinc alloy in the solder to fuse to the surface of the metal causing cleaning problems and a porous and weak seam.

Checklist for Successful soldering:

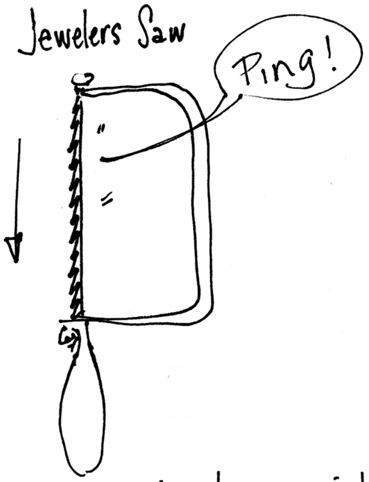
☑ Close-fitting Joints
☑ Clean surfaces
☑ Careful fluxing
☑ The right amount, placement, and type of solder
☑ Removal of foreign objects
☑ Careful but quick preheating
☑ Even heat with the correct flame over the entire metal area
☑ Enough heat to cause a complete solder flow
☑ Correct cleaning and refluxing between solderings

Melting Points of the Most Commonly Used Silver Solders:

Hard Solder	1450 °F 788 °C	Sterling Silver	1640 °F 893 °C
Medium Solder	1360 °F 738 °C	Yellow Brass	1660 °F 904 °C
Easy Solder	1325 °F 718 °C	Copper	1981 °F 1083 °C

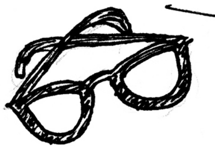
SOME Metalsmithing Basics:

Jewelers Saw

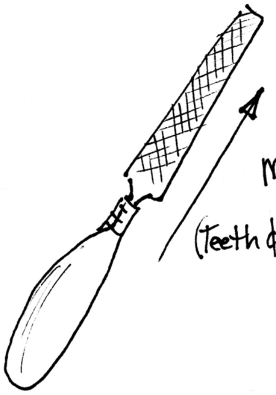


- Teeth of blade always point down toward handle.
- Blade will make a nice "ping" when tension is good.

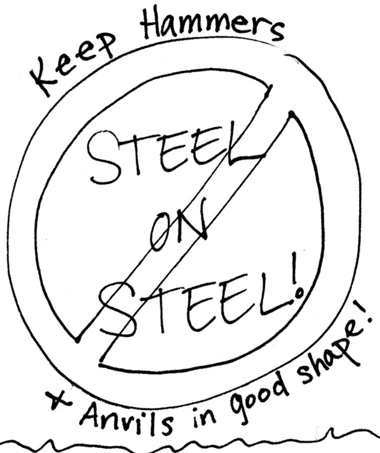
SAFETY FIRST!



- Hair back
- Eyes Protected
- Follow directions/ precautions



Apply pressure on the forward motion while filing. (Teeth don't cut on the back motion ü)



Keep Hammers STEEL ON STEEL!

× Anvils in good shape!

No Pewter or Aluminum in the Metals studio (it contaminates equipment)

☆ If you are unsure ☆ of the proper tool to use or the proper use of a tool...

STOP, ASK & LEARN.

Saves from injury to self and equipment. ☆ ☆

RIVETING HANDOUT

Standard, raised, tube, pivot,
And managing multiples

Written by: Lucy Louise Derickson

This document is a helpful guide for riveting sheet metal designs. It is intended for riveting primarily flat, stacked layers of metal. If your design includes any non-flat sheet, check with your instructor for strategy and tips.

Angela Dalio
Hand Brooch
Copper sheet, Brass rivets
3''x 2''x ¼''
Course: Intro Jewelry and Metals, Montgomery College

ORDER OF OPERATIONS: Quick Reference

1. Create: Saw/texture layers of sheet metal.
2. Drill rivet holes

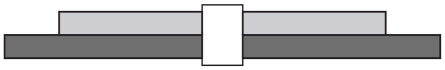
   **For small pieces, drill a hole first, then cut it out.*
3. Clean up: File, sand all edges and surfaces
4. Finishing: Patina or polish
5. **Set Rivets**

**Some exceptions to this order for Flush Rivets*

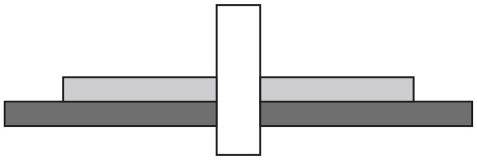
Rivet Basics

The fit and height of the rivet wire in relation to the drilled hole, and gauge of sheet is very important. It must be just right so that the rivet wire will compress, rather than crumple or fold when hammered. The rivet wire must be long enough for a rivet head to form when hammered, securing the sheets together.

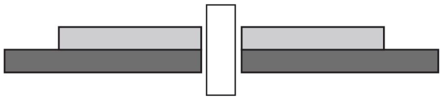
NO! Rivet wire is too short!
You will not create a rivet head.



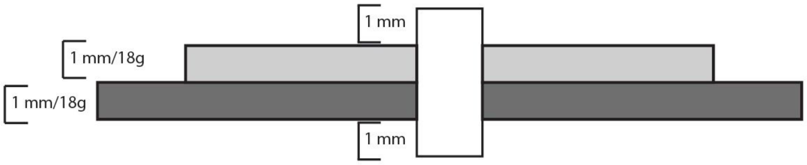
NO! Rivet wire is too long!
Your wire will flop over, and not compress.



NO! Rivet wire is too thin!
Your wire will fold, and not compress.



YES! Rivet wire is the correct length and thickness!
It fits snug in the drill hole and will not fold over when hammered, creating a nice rivet head.



**This diagram shows rivet wire PRIOR to hammering.*

MORE Tips:

Keep holes accurate! Once your holes are drilled, the metal cannot be textured, bent, or formed in any way. This will stretch or alter your rivet holes.

Prep your rivet wire. Anneal your rivet material so it will compress when hammered. File the ends of your rivet wire flat so that it will compress evenly. (Note: when using wire cutters, the end of your wire will be pinched, not flat. File it).

Support your rivet wire. The rivet cannot go through an empty space. This will always cause the rivet wire to bend, rather than compress. Make certain your layers are flush against each other, or add a support material such as a tight fitting heavy wall tubing.

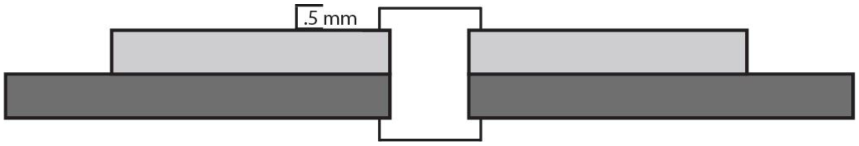
Setting your rivets: Work slowly and gently. Hammer lightly and with good control. Only let your rivet hammer contact the rivet wire (not your beautiful sheet!). Don't heat work once rivets are set, this will anneal the rivet wire, and make them fragile.

Alternative Materials: Riveting is great for connecting alternative materials together. BUT, you will usually need to sandwich that material between two pieces of metal.

Multiple rivets: Special care is needed to ensure holes line up. *See steps on the last page.*

Step by Step Instructions

Standard Wire Rivet:

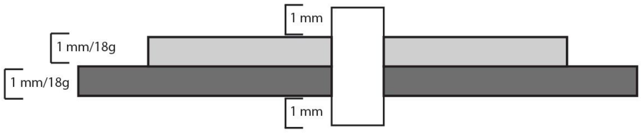


Prepare your sheet metal for riveting

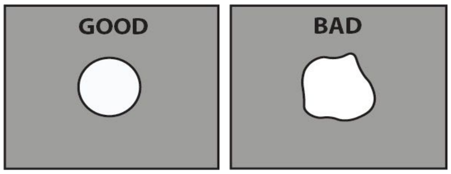
1. **Center punch** the top layers where you intend to drill.
   *When layers are very small, drill before you saw
2. **Secure layers** together using masking tape. Use a drilling clamp when appropriate, especially for drilling larger holes for tube rivets.
3. **Drill** the appropriate holes through both layers of metal
4. **Clean up:** Once all the holes are drilled, take the tape off and sand the surfaces as desired (usually to 600grit)
5. **Patina:** Add patinas where desired.
6. Now that your holes are drilled and your surfaces are beautiful, you are ready to CAREFULLY set your rivets.

Set your rivets

1. **Use annealed wire.** You can anneal before or after you cut. Small pieces are easily lost, but soft wire is more bendable. Keep your wire straight!
2. **Measure and cut your rivet wire.**
   Your wire should be about **2mm + the thickness** of your stacked metal.
   If you are using two layers of 20g or 18g metal your wire will be about 4mm.

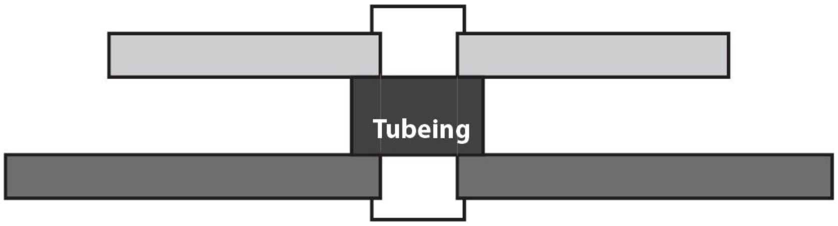


3. Place your rivet wire into your drilled layers. Split the amount of rivet wire so there is **1mm on the top** and **1mm on the bottom**.
4. Using a **rivet hammer** and a **steel plate**, gently tap the rivet wire to set your rivet. Alternate between the top and bottom to make sure that your wire is evenly displaced. Your rivet wire should only be in contact with the steel block and the hammer head. **Your sheet metal will be hovering above the plate, not touching it.** .
5. The rivet head will look round, and slightly raised above the surface on each side.



DO NOT HAMMER SO HARD THAT YOUR RIVET LOOKS LIKE A PANCAKE.
This is a delicate controlled process!

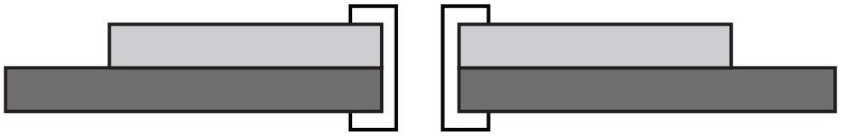
Raised Rivet:



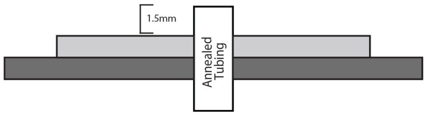
1. You will need a piece of **heavy wall tubing** that fits your rivet wire perfectly!
   Do not anneal this tubing. Use a tube cutter, and cut it to whatever length you want.
2. File tubing totally flat. It cannot have any angle whatsoever, or your top plate will follow that angle. (Trick: Use a flex shaft, but don't squish it!)
3. Set your rivet the **same as a Standard Rivet**.

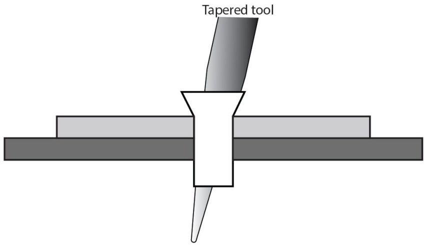
   *Note: A raised rivet can also be used with a variety of different rivet heads. Mix and match as you wish!

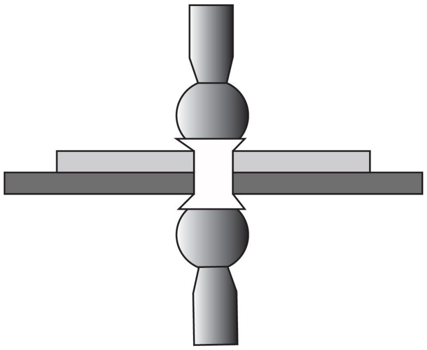
Tube Rivet:



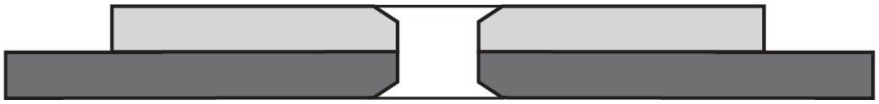
1. You will need **thin wall tubing** that fits snugly into your drilled hole.
2. Measure and cut tubing about **3mm + the thickness** of your stacked metal. **This might vary based on the size of the hole/tube. Experiment a little!*
3. **File and sand the tubing totally flat** and smooth. (Trick: Use a flex shaft, but don't squish it!)
4. **Anneal the tube!**
5. Place the tube through your rivet hole. Divide the excess between each side. (approx. 1.5mm)
6. **Start to flare** both sides of your tubing using a tapered steel tool (center punch or scribe works well).
7. Continue to encourage the tubing to flare with some **dapping punches.** Place one punch in a vice, and hold the other above, and strike with a hammer. Gradually use larger dapping punches, don't flare it too quickly or the tube will fold.
8. **Finally register your tube rivet totally flat** against your sheet using a rawhide or plastic mallet and your steel block (See top diagram for end result).
   Be gentle. Protect your sheet metal.







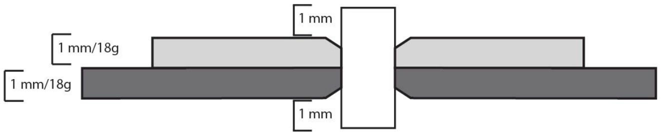
Flush Rivet:

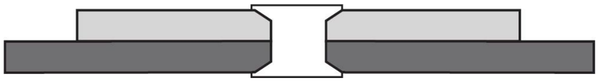


NOTE: The order of operations will be different with a flush rivet. The flush rivet needs to be sanded to 600, **after it has been set**, so that it will blend in with the metal around it. This means any patina would be sanded away as well. Plan accordingly.

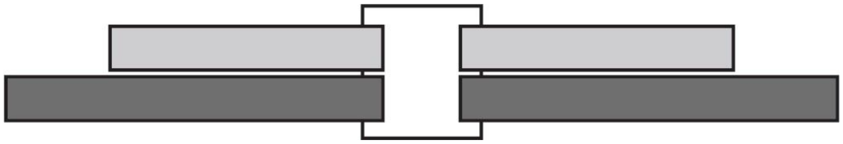
1. Prepare rivet wire exactly the same as a standard rivet. *Mind the note above.*

2. Countersink your drill hole by using a slightly larger drill bit. While rotating, kiss the top of the previously drilled hole. This will leave you with more of a **funnel**, not a straight drill hole. *A bur can also be used to do this.*
   ***The countersink cannot be more than ½ way through the thickness** of the metal sheet. If you go too far, you just made a new hole.
3. **Continue with standard rivet procedure**.
4. Hammer rivet head so that it expands and fills the countersunk space.
5. Once set and stable, **sand the surface totally flat**, and the rivet will be completely flush with the surface of the metal (see top diagram for end result). If using the same metal for wire and sheet, it should be practically invisible.

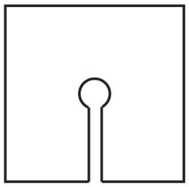




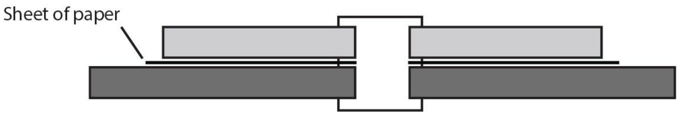
Pivot Rivet:



1. To allow for movement in a riveted piece, a piece of index card may be placed between the materials to be riveted prior to setting the rivet.
2. Punch a hole and cut a slit in the paper.
3. Place the paper between the sheet metal. Make sure the hole is where the rivet is going through.
4. Set the rivet using your preferred rivet style.
5. Then remove the paper. Your top sheet should swivel.



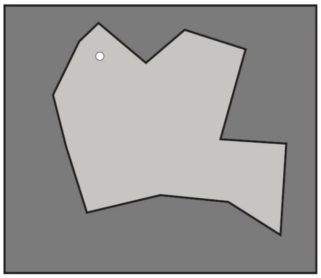
Cut a hole and slit in the paper

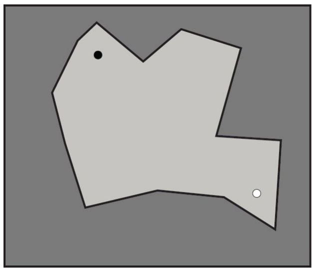


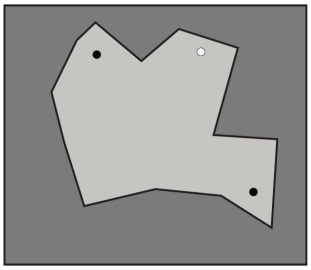
Strategy for Multiple Rivets in one piece!

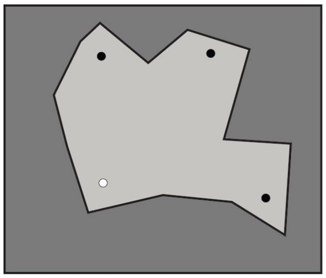
When placing more than one rivet in a single sheet of material, it is crucial that all the holes line up! This means it is ESSENTIAL that the sheet metal does not shift as you move through drilling the holes. A slight shift means nothing will line up later. If this happens, you may have to re-drill everything a little bigger, and use a larger rivet wire. This can be quite stressful when you thought you were on your very last step, and now are back at the beginning again! So take extra, EXTRA, care to do this correctly.

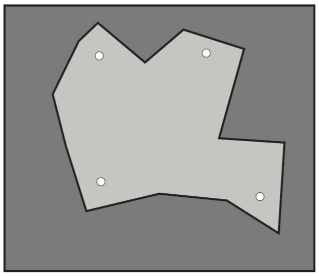
1. You can use any style of rivet mentioned above.
2. **Center punch** the **top layer of metal all the places** you want your rivets to be.
3. Tape pieces together securely. Make sure you can still see the center punch marks. TIP: Some **vices** might be enough to hold the work throughout drilling. Pieces could also be **super glued** together. A little heat will release them later, but you must have good ventilation for this, and don't fully anneal the pieces! It's best they stay work hardened.
   Regardless, try the following steps to keep the layers from shifting while drilling.

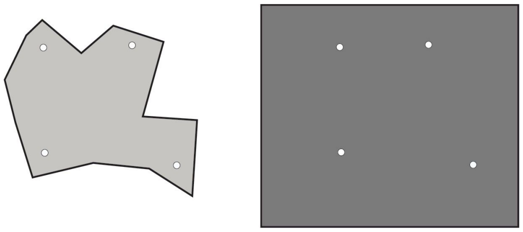

Drill first hole


Plug first hole, drill second


Plug second hole, drill third


Plug third hole, drill fourth.
At this point, the two layers should not be able to shift.
Drill all remaining holes


Remove all plugs


Separate sheets
Sand to 600, patina or polish as desired.
DO NOT hammer or bend. Your hole will shift!
When ready, set rivets in preferred style.

ANOTHER WAY! You have the option to drill and set rivets all at once. For example, drill hole one, set rivet one, drill hole two, set rivet two, drill hole three, etc.
The drawback to this method is that you will not be able to sand your sheet metal surface easily with little rivet heads everywhere. Additionally, this will make it difficult to keep a nice patinated surface, because the drilling process can be damaging (tape, oil, fingers etc). You can try and see. You can patina your metal AFTER rivets are set, but it might create some limitations in your design. For example, you won't be able to use liver sulfur on only ONE layer now that they are joined. Whatever your intentions, plan accordingly. EXPERIMENT to learn your preferences!

SO FRESH + SO CLEAN 2021

ETHICAL METALSMITHS STUDENTS

RIVETING HANDOUT

Standard, raised, tube, pivot, And managing multiples

Written by: Lucy Louise Derickson

This document is a helpful guide for riveting sheet metal designs. It is intended for riveting primarily flat, stacked layers of metal. If your design includes any non-flat sheet, check with your instructor for strategy and tips.

Angela Dalio
Hand Brooch
Copper sheet, Brass rivets
3''x 2''x ¼''
Course: Intro Jewelry and Metals, Montgomery College

ORDER OF OPERATIONS: Quick Reference

1. Create: Saw/texture layers of sheet metal.
2. Drill rivet holes

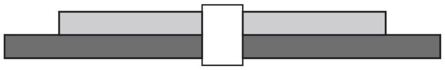
   **For small pieces, drill a hole first, then cut it out.*
3. Clean up: File, sand all edges and surfaces
4. Finishing: Patina or polish
5. **Set Rivets**

**Some exceptions to this order for Flush Rivets*

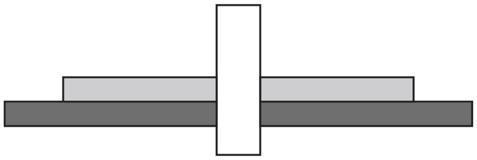
Rivet Basics

The fit and height of the rivet wire in relation to the drilled hole, and gauge of sheet is very important. It must be just right so that the rivet wire will compress, rather than crumple or fold when hammered. The rivet wire must be long enough for a rivet head to form when hammered, securing the sheets together.

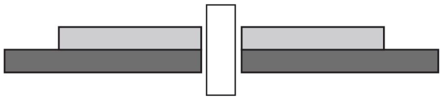
NO! Rivet wire is too short!
You will not create a rivet head.



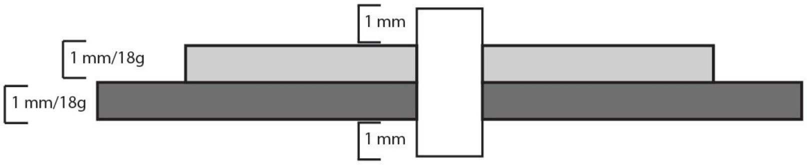
NO! Rivet wire is too long!
Your wire will flop over, and not compress.



NO! Rivet wire is too thin!
Your wire will fold, and not compress.



YES! Rivet wire is the correct length and thickness!
It fits snug in the drill hole and will not fold over when hammered, creating a nice rivet head.



**This diagram shows rivet wire PRIOR to hammering.*

MORE Tips:

Keep holes accurate! Once your holes are drilled, the metal cannot be textured, bent, or formed in any way. This will stretch or alter your rivet holes.

Prep your rivet wire. Anneal your rivet material so it will compress when hammered. File the ends of your rivet wire flat so that it will compress evenly. (Note: when using wire cutters, the end of your wire will be pinched, not flat. File it).

Support your rivet wire. The rivet cannot go through an empty space. This will always cause the rivet wire to bend, rather than compress. Make certain your layers are flush against each other, or add a support material such as a tight fitting heavy wall tubing.

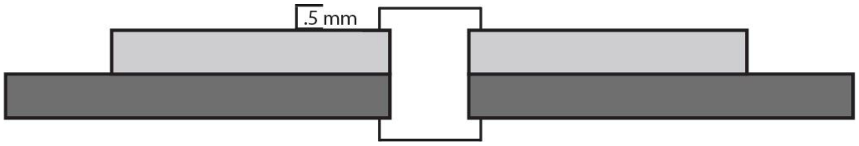
Setting your rivets: Work slowly and gently. Hammer lightly and with good control. Only let your rivet hammer contact the rivet wire (not your beautiful sheet!). Don't heat work once rivets are set, this will anneal the rivet wire, and make them fragile.

Alternative Materials: Riveting is great for connecting alternative materials together. BUT, you will usually need to sandwich that material between two pieces of metal.

Multiple rivets: Special care is needed to ensure holes line up. *See steps on the last page.*

Step by Step Instructions

Standard Wire Rivet:

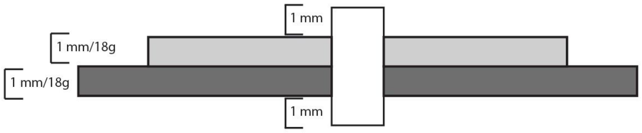


Prepare your sheet metal for riveting

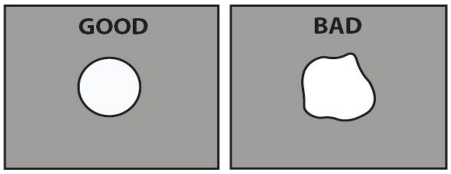
1. **Center punch** the top layers where you intend to drill.
   *When layers are very small, drill before you saw
2. **Secure layers** together using masking tape. Use a drilling clamp when appropriate, especially for drilling larger holes for tube rivets.
3. **Drill** the appropriate holes through both layers of metal
4. **Clean up:** Once all the holes are drilled, take the tape off and sand the surfaces as desired (usually to 600grit)
5. **Patina:** Add patinas where desired.
6. Now that your holes are drilled and your surfaces are beautiful, you are ready to CAREFULLY set your rivets.

Set your rivets

1. **Use annealed wire.** You can anneal before or after you cut. Small pieces are easily lost, but soft wire is more bendable. Keep your wire straight!
2. **Measure and cut your rivet wire.**
   Your wire should be about **2mm + the thickness** of your stacked metal.
   If you are using two layers of 20g or 18g metal your wire will be about 4mm.

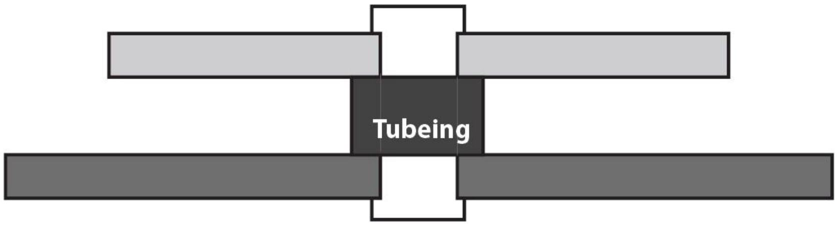


3. Place your rivet wire into your drilled layers. Split the amount of rivet wire so there is **1mm on the top** and **1mm on the bottom**.
4. Using a **rivet hammer** and a **steel plate**, gently tap the rivet wire to set your rivet. Alternate between the top and bottom to make sure that your wire is evenly displaced. Your rivet wire should only be in contact with the steel block and the hammer head. **Your sheet metal will be hovering above the plate, not touching it.** .
5. The rivet head will look round, and slightly raised above the surface on each side.



DO NOT HAMMER SO HARD THAT YOUR RIVET LOOKS LIKE A PANCAKE.
This is a delicate controlled process!

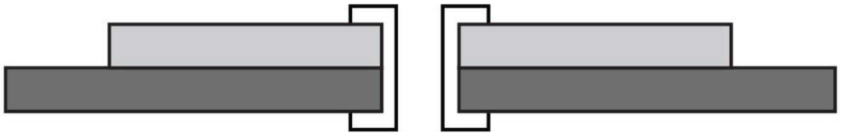
Raised Rivet:



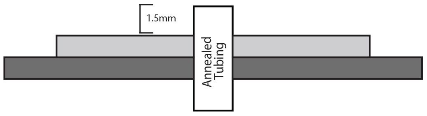
1. You will need a piece of **heavy wall tubing** that fits your rivet wire perfectly!
   Do not anneal this tubing. Use a tube cutter, and cut it to whatever length you want.
2. File tubing totally flat. It cannot have any angle whatsoever, or your top plate will follow that angle. (Trick: Use a flex shaft, but don't squish it!)
3. Set your rivet the **same as a Standard Rivet**.

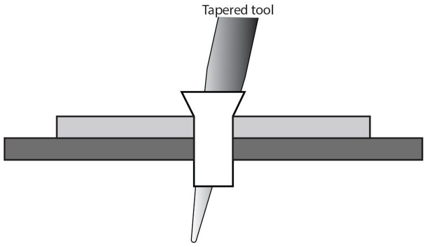
   *Note: A raised rivet can also be used with a variety of different rivet heads. Mix and match as you wish!

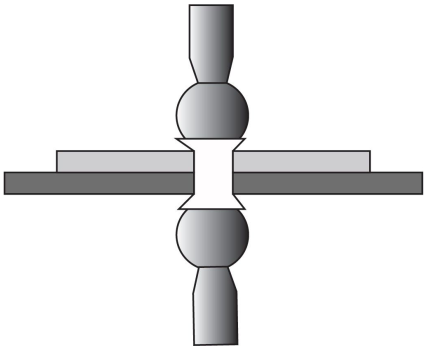
Tube Rivet:



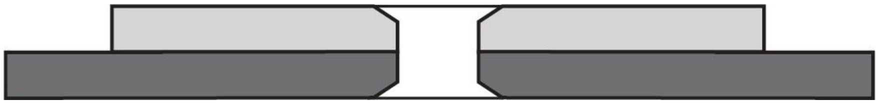
1. You will need **thin wall tubing** that fits snugly into your drilled hole.
2. Measure and cut tubing about **3mm + the thickness** of your stacked metal. **This might vary based on the size of the hole/tube. Experiment a little!*
3. **File and sand the tubing totally flat** and smooth. (Trick: Use a flex shaft, but don't squish it!)
4. **Anneal the tube!**
5. Place the tube through your rivet hole. Divide the excess between each side. (approx. 1.5mm)
6. **Start to flare** both sides of your tubing using a tapered steel tool (center punch or scribe works well).
7. Continue to encourage the tubing to flare with some **dapping punches.** Place one punch in a vice, and hold the other above, and strike with a hammer. Gradually use larger dapping punches, don't flare it too quickly or the tube will fold.
8. **Finally register your tube rivet totally flat** against your sheet using a rawhide or plastic mallet and your steel block (See top diagram for end result).
   Be gentle. Protect your sheet metal.







Flush Rivet:



NOTE: The order of operations will be different with a flush rivet. The flush rivet needs to be sanded to 600, **after it has been set**, so that it will blend in with the metal around it. This means any patina would be sanded away as well. Plan accordingly.

1. Prepare rivet wire exactly the same as a standard rivet. *Mind the note above.*

2. Countersink your drill hole by using a slightly larger drill bit. While rotating, kiss the top of the previously drilled hole. This will leave you with more of a **funnel**, not a straight drill hole. *A bur can also be used to do this.*
   ***The countersink cannot be more than ½ way through the thickness** of the metal sheet. If you go too far, you just made a new hole.
3. **Continue with standard rivet procedure**.
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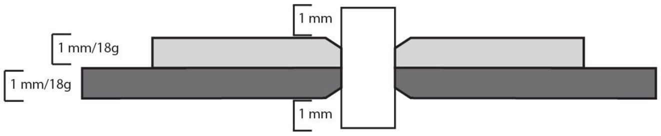
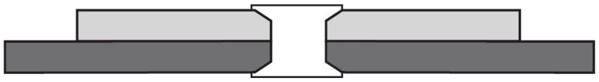
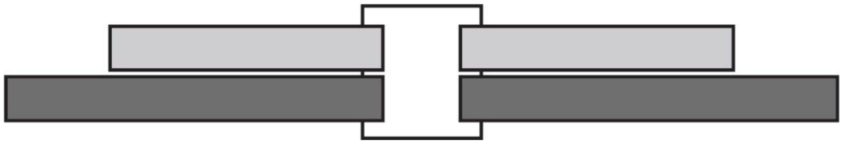




Pivot Rivet:



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2. Punch a hole and cut a slit in the paper.
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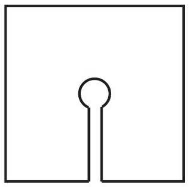
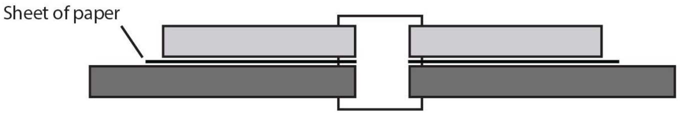


Cut a hole and slit in the paper



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1. You can use any style of rivet mentioned above.
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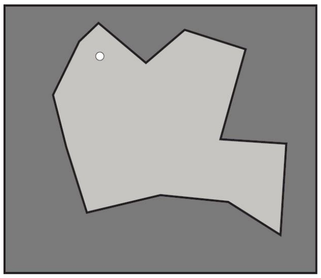
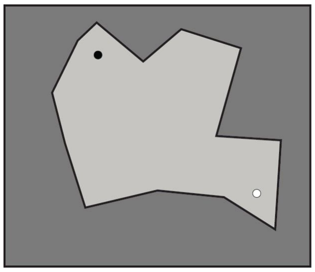
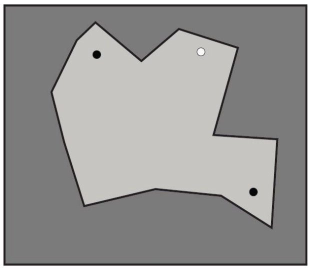


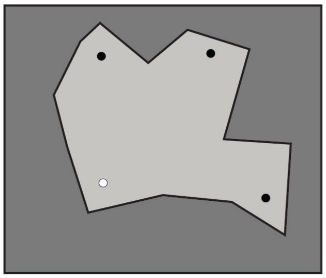
Drill first hole



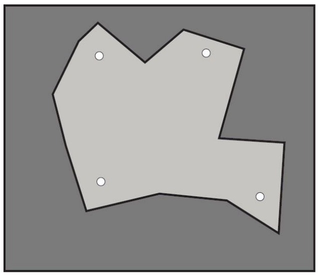
Plug first hole, drill second



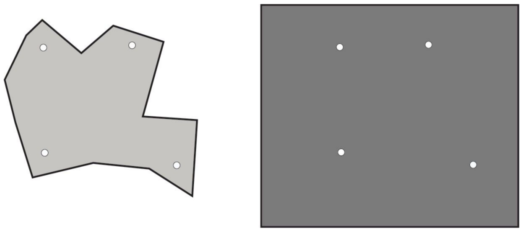
Plug second hole, drill third



Plug third hole, drill fourth.
At this point, the two layers should not be able to shift.
Drill all remaining holes



Remove all plugs



Separate sheets
Sand to 600, patina or polish as desired.
DO NOT hammer or bend. Your hole will shift!
When ready, set rivets in preferred style.

ANOTHER WAY! You have the option to drill and set rivets all at once. For example, drill hole one, set rivet one, drill hole two, set rivet two, drill hole three, etc.
The drawback to this method is that you will not be able to sand your sheet metal surface easily with little rivet heads everywhere. Additionally, this will make it difficult to keep a nice patinated surface, because the drilling process can be damaging (tape, oil, fingers etc). You can try and see.
You can patina your metal AFTER rivets are set, but it might create some limitations in your design. For example, you won't be able to use liver sulfur on only ONE layer now that they are joined.
Whatever your intentions, plan accordingly. EXPERIMENT to learn your preferences!

Roller Printing

The process of Roller Printing enables you to put a permanent texture or pattern onto sheet metal leaving an embossed surface using a Roller Mill. Most materials can be used to make an impression onto sheet metal such as: pierced metal, metal screen or wire mesh, wire, washers, lace, sandpaper, paper, natural objects, etc. Other techniques include: etching a metal plate and rolling a print, hammering or stamping patterns in a plate and rolling a print, or making a pierced metal template to make several examples of the same pattern. Experimenting can increase the number of interesting effects that you can create. For the piece of metal you plan to print, use 24 to 14 gauge sheet metal. No Steel.

Procedure for a found material print:

1) Finish a sheet of metal to 600 grit sandpaper (removing burrs as well) and anneal. The sheet must be finished to its final surface before rolling through the mill (any later sanding will remove the roller printed pattern).

2) Cut a piece of metal slightly larger than the final size that you want and anneal.

3) Place the object that will be causing the print face down onto the metal to be printed. It is recommended that you run a test piece of the same gauge and metal of the piece that you plan to print.

4) Wipe of the oil, dust, or any other foreign matter from the rollers with a clean scratch pad and 3 in 1 Oil.

5) Tighten the rollers using the crank on the top. Make it tight enough so the rollers have a good grip on the metal without being too tight. Make a small mark in chalk on the gears at this point. You should know the correct pressure needed because of your previous experimentation with the test pieces. Make sure that you can still roll the sheets through without too much strain.

6) Roll the sheets through the mill in a continuous motion. If you have tightened too much and are unable to roll through continuously, there will be marks left on the metal and the metal that you are printing may be ruined.

7) Catch the printed metal as it comes out of the back of the rollers and re-oil the mill with 3 when you are finished.

Procedure for printing with a template:

You can make a template out of brass (18 gauge or thicker for repeated use).

- Graph paper is recommended for all-over patterns and may be glued on with white glue for piercing.
- Drill the necessary holes for the pierced pattern.
- When you have finished, soak the template in hot water to remove the paper.
- Remove any piercing burrs with 600 grit sandpaper wrapped around a wood stick or a flat file.

For printing with a template, follow the directions above making sure that the template and metal to be printed are placed sanded side together in the roller.

Roller Printing Continued

Notes:

~ If the printed sheet has become bowed through the rolling process, anneal the metal on a clean fire brick and while red hot place another clean fire brick on top and flatten slowly. Repeat until the metal is flat.

~ *Do not anneal templates.* It needs to be hard so they won't distort during the rolling process. Stamped and hammered templates should be annealed if you are doing a lot of stamping or hammering. The template will become work hardened through the stamping or hammering process and will print well when rolled against annealed metal.

~ Do anneal the metal that is to receive the print.

~ Remember that anything that is on the plate or between the plates will print. This includes dirt, tape residue, scratches, etc.

~ The printed impression is created because the metal is being rolled to a thinner gauge and the areas where the metal is pierced or stamped is retaining the original thickness. The template (except for one made of steel) will be elongated a little and may curl as a result of the rolling process.

~ *Sandwich a steel plate between two pieces of copper to protect the rollers.*

~ Remember that this process is a one shot deal for the piece of metal that receives the print. Templates may be flattened and reused several times if the distortion of elongation does not bother you.

~It is fun to experiment and roller print a piece of metal with several materials at once. You may also print one texture onto the metal, anneal, flatten, and roller print a second texture onto the same piece.

Determining Ring Blank Lengths in B. & S. Gauge

Sizes (U.S.A.)	Length (mm)	Metal Thickness – B. & S. Gauge						
		12	14	16	18	20	22	24
1	39.0	45.5	44.2	43.0	42.1	41.5	40.9	40.5
1 ¼	39.6	46.2	44.6	43.6	42.7	42.1	41.5	41.1
1 ½	40.2	46.9	45.2	44.3	43.3	42.7	42.1	41.8
1 ¾	40.8	47.7	45.8	44.9	44.0	43.3	42.7	42.4
2	41.5	48.0	46.5	45.5	44.6	44.0	43.3	43.0
2 ¼	42.1	48.7	47.1	46.2	45.2	44.6	44.0	43.6
2 ½	42.7	49.3	47.7	46.8	45.8	45.2	44.6	44.3
2 ¾	43.4	49.9	48.4	47.4	46.5	45.8	45.2	44.9
3	44.0	50.6	49.0	48.0	47.1	46.5	45.8	45.6
3 ¼	44.6	51.2	49.6	48.7	47.7	47.1	46.5	46.2
3 ½	45.2	51.8	50.2	49.3	48.4	47.7	47.1	46.8
3 ¾	45.9	52.4	50.9	49.9	49.0	48.4	47.7	47.4
4	46.5	53.1	51.5	50.6	49.6	49.0	48.3	48.0
4 ¼	47.1	53.7	52.1	51.2	50.2	49.6	49.0	48.7
4 ½	47.8	54.3	52.8	51.8	50.9	50.2	49.6	49.3
4 ¾	48.4	55.0	53.4	52.4	51.5	50.9	50.2	49.9
5	49.0	55.6	54.0	53.1	52.1	51.5	50.9	50.6
5 ¼	49.6	56.2	54.6	53.7	52.8	52.1	51.5	51.2
5 ½	50.3	56.8	55.3	54.3	53.4	52.7	52.1	51.8
5 ¾	50.9	57.5	55.9	55.0	54.0	53.4	52.8	52.4
6	51.5	58.1	56.5	55.6	54.6	54.0	53.4	53.1
6 ¼	52.2	58.7	57.1	56.2	55.3	54.6	54.0	53.7
6 ½	52.8	59.3	57.8	56.8	55.9	55.3	54.6	54.3
6 ¾	53.4	60.0	58.4	57.5	56.5	55.9	55.3	55.0
7	54.0	60.6	59.0	58.1	57.1	56.5	55.9	55.6
7 ¼	54.7	61.2	59.7	58.7	57.8	57.1	56.5	56.2
7 ½	55.3	61.9	60.3	59.3	58.4	57.8	57.1	56.8
7 ¾	55.9	62.5	60.9	60.0	59.0	58.4	57.8	57.5
8	56.6	63.1	61.5	60.6	59.7	59.0	58,4	58.1
8 ¼	57.2	63.7	62.2	61.2	60.3	59.7	59.0	58.7
8 ½	57.8	64.4	62.8	61.9	60.9	60.3	59.7	59.3
8 ¾	58.4	65.0	63.4	62.5	61.5	60.9	60.3	60.0
9	59.1	65.6	64.1	63.1	62.2	61.5	60.9	60.6
9 ¼	59.7	66.3	64.7	63.7	62.8	62.2	61.5	61.2
9 ½	60.3	66.9	65.3	64.4	63.4	62.8	62.2	61.9
9 ¾	60.9	67.5	65.9	65.0	64.1	63.4	62.8	62.5
10	61.6	68.1	66.6	65.6	64.7	64.1	63.4	63.1
10 ¼	62.2	68.8	67.2	66.3	65.3	64.7	64.1	63.7
10 ½	62.8	69.4	67.8	66.9	65.9	65.3	64.7	64.4
10 ¾	63.5	70.0	68.5	67.5	66.6	65.9	65.3	65.0
11	64.1	70.7	69.1	68.1	67.2	66.6	65.9	65.6
11 ¼	64.7	71.3	69.7	68.8	67.8	67.2	66.6	66.3
11 ½	65.3	71.9	70.3	69.4	68.5	67.8	67.2	66.9
11 ¾	66.0	72.5	71.0	70.0	69.1	68.5	67.8	67.5
12	66.6	73.2	71.6	70.7	69.7	69.1	68.5	68.1
12 ¼	67.2	73.8	72.2	71.3	70.3	69.7	69.1	68.8
12 ½	69.7	74.4	72.8	71.9	71.0	70.3	69.7	69.4
12 ¾	68.5	75.0	73.5	72.5	71.6	71.0	70.3	70.0
13	69.1	75.7	74.1	73.2	72.2	71.6	71.0	70.7

SOURCES FOR MATERIALS AND SUPPLIES:

Griffy's Art Supply
725 W. Kirkwood Avenue
Bloomington
812-272-1502

Bloomington Hardware
2700 E Convenanter Dr
Bloomington
812-339-7575

Michaels
120 N Gates Drive
Bloomington
812-339-4835

Staples
2815 W 3rd St
Bloomington
812-330-8880

Joanne Fabrics
3483 W Third St
Bloomington
47404
812-332-1218

Moonshine Leather Company
38 S VAn Buren St
Nashville, IN 47448
812-988-1326

Geralds Wood Shed
4175 S Swartz Ridge Road
Bloomington
812-339-9663

Bloomington Iron and Metal (BIM) steel and aluminum scraps, old tool and strange objects
503 N Rogers Street
Bloomington
812-336-6884

Wear closed toe shoes, bring gloves, go into the office and ask for permission to look through the scrap yard, mention IU Art Department.

Kleindorfer's Hardware and Variety (screws and nails by the pound, live crickets, new tools)
1401 W Kirkwood Ave
Bloomington
812-332-0487

Bender Lumber
6002 State Road 46
Bloomington
812-339-9737

Black Lumber Company
1710 S Henderson Street
Bloomington
812-32-7208

Lowe's
350 N Gates Drive
Bloomington
812-323-0899

Menards
1285 S Liberty Drive
Bloomington
812-339-6210

Habitat for Humanity Restore
(building materials, doors, paint, foam insulation, wood, furniture, hardware, used power tools)
2450 S Henderson Street
Bloomington
812-331-2660

IU Surplus
(Furniture, Cords, Electronic Parts, Shelving, Scraps)
2931 E 10th Street
Bloomington
812-855-2475

Goodwill (Clothing, toys, appliances, furniture)

840 S Auto Mall Road
Bloomington
812-331-8170

1284 Liberty Drive
Bloomington
812-336-8104

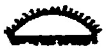
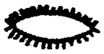
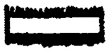
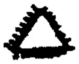
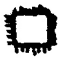
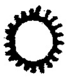
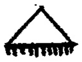
Salvation Army (Clothing, toys, appliances, furniture)
111 N Rogers Street
Bloomington
812-336-4310

Catalog/Online Sources

Rio Grande	www.riogrande.com
Hoover and Strong	www.hooverandstrong.com
Gesswein	www.gesswein.com
Metalliferous	www.metalliferous.com
Contenti	www.contenti.com
Otto Frei	www.ottofrei.com
Pepe Tools	www.pepetools.com
Allcraft	www.allcraftusa.com

DEFINITION OF TOOLS

☐ANNEALING PAN	A revolving metal pan, filled with lump pumice or other heat-reflecting material. Used to support large material while annealing or soldering.
☐BENCH PIN	A wood block fastened to the work bench and used to support work while piercing or filing.
☐BURNISHER	A smooth, polished steel tool set in a wood handle used to set cabochon stones.
☐CENTER PUNCH	A pointed steel tool used to make an indentation before starting a drill or for marking the center of a circle on metal which will hold the compass point in place.
☐COPPER TONGS	Copper tongs are used to remove work from acid because iron or steel tongs will contaminate the acid and cause copper plating on silver.
☐DAPPING DIE	A metal cube with hemispherical shapes of various sizes into which thin metal can be rounded into shallow dish forms or hemispheres with dapping punches.
☐DRAWPLATE	A flat piece of steel with graduated holes for reducing or drawing wire into a finer gauge. They are made in various sizes and shapes including round, square, and oval.
☐DRAW TONGS	A special pair of pliers for pulling wire through the drawplate.
☐FILES, GENERAL	Tools for removing metal and cleaning rough edges. They are made in various shapes and sizes. Some of the shapes are:

Half Round	Crossing	Equaling	Triangular	Square	Round	Barrette
						

☐COMPARISON OF CUTS

Swiss Cut	American Mill Cut
00, 0, 1, 2, 3, 4, 6	Course, Bastard, Second, Smooth

☐FILES, NEEDLE	Special small files for jewelry made in the same shape as regular hand files.
☐JEWELER'S SAW BLADES	Small blades used in a jeweler's saw frame for cutting metal. Available in many sizes, 8/0 being the finest to 10 the coarsest.
☐JEWELER'S SAW FRAME	An adjustable saw frame for holding jeweler's saw blades.
☐B&S METAL GAUGE	A Brown and Sharp Gauge for measuring the thickness of sheet metal and wire.

☐PLIERS	There are many types of pliers used in jewelry work, including: -Flat Nose -Chain Nose -Round Nose
☐POLISHING BUFFS	There are many different kinds of wheels used with a polishing motor for putting a finish on metal. Each different shape and material has its own advantages.

Standard Muslin	Soft Muslin	Hard Felt
Used with Tripoli or white diamond for fast cutting.	Used with red rouge for a soft final finish.	Used with both red rouge and Tripoli when sharp edges are needed. Best for achieving a high polish on flat surfaces.

☐POLISHING MOTOR	A special motor for buffing that is equipped on both sides with a tapered spindle to hold felt, muslin, or other buffs.
☐RAWHIDE MALLET	A leather mallet designed for flattening and forming metal without leaving surface marks.
☐RING CLAMP	A clamp used to hold rings and other pieces of jewelry while filing, setting stones, etc.
☐RING MANDREL	A tapered steel mandrel around which rings are formed.
☐ROLLING MILL	A hand-operated mill for reducing the thickness of sheet metal, flattening wire, printing pattern onto sheet, etc. When fed through the mill, the metal is compressed between two rollers to an even thickness.
☐SCRIBE	A pointed steel tool used for making guidelines or scratched in metal.
☐STAKE	A general term for steel anvils, mandrels, and special tools upon which metal is hammered and formed.

Vocabulary

Annealing: The process of heating certain metals to a point where their molecular structure is relaxed.

Bending: Producing simple curves in one dimension, as in a ring, cylinder or cone, by hand pressure alone or with a jig, mallet, or pliers.

Bouging: The process of hammering out the irregularities and surface depressions on a piece of hollowware.

Course: A complete series of rounds of raising, stretching, or planishing done on a piece of hollowware.

Crimping: The process of hammering valleys or flutes into a metal disc with a raising hammer and fluting stake. This causes the disc to assume a "bowl shape". The flutes are then hammered out with raising hammer over a stake, compressing the metal and causing the bowl form to remain.

Ductility: The ability of a metal to be drawn down into wire.

Electroplating: The adhering process of metal on top of another by running electrical current through a conductive solution of metal salts.

Ferrule: An extended portion of an object intended to hold or attach to a handle or knob.

Finial: An ornamental or functional knob on an object such as is often found on the lid of a coffee pot.

Folding: A method by which flat faces and angular corners, as distinguished from curved surfaces can be produced.

Forging: The process of controlled shaping of metal rod or bar stock by the force of hammers against stakes. Many non-ferrous metals can be forged hot or cold.

Fusibility: The tendency of a metal to become molten or to unite with other metals in the presence of heat.

Hollowware: The term used to describe volumetric forms traditionally refers to those made of sterling silver such as coffeepots and teapots. Hollowware can be made by hand using hammers and stakes, or through mechanized processes such as spinning and stamping.

Malleability: The capacity of a metal to be hammered and rolled without cracking or breaking (the opposite of brittleness). Pure silver and gold are the two most malleable metals: they can be hammered into sheets so thin that light passes through.

Planishing: A metalsmithing term derived from Latin "planus", which means to flatten or level, therefore, it is a finishing process of hammering used to smooth and harden metal so that the surface is even and regular. A light convex, highly polished hammer (Planishing Hammer) is used to lay down a series of very gently, overlapping blows on the metal and against a stake with a radius slightly smaller than the curve of the piece.

Pitch: A tar, tallow and plaster mixture used as a support for planishing hollowware and repoussé work.

Raising: The general process of making a volumetric form from a flat sheet of thin metal with hammers and stakes which includes specific processes as angle-raising, stretching and crimping.

Round: A complete circle of raising, stretching, or planishing around a piece of hollowware.

Sinking: A versatile technique used to create domical forms in sheet metal by pounding the metal into a hemispherical die on what becomes the inside of the piece. On a small scale, it is called dapping, on a larger scale, can be used by itself or as a first step in raising.

Soldering: The process of joining two pieces of metal together with an alloy (solder) that melts at a lower temperature.

Stretching: The process of thinning and spreading metal by displacing it between a hammer and a stake. For example, in stretching a bowl, a polished ball peen hammer is used in conjunction with the polished flat face of an anvil.

Swaging: A process involving compression, in which metal is hammered until it thickens; "necking-in" as in the narrow neck of a bottle.